REMARKS

Applicant acknowledges Examiner's confirmation of election without traverse of Invention 1, as defined by the Examiner. Further, Applicant acknowledges Examiner's confirmation that Mitchell et al. fails to teach the use of at least two different models.

Applicant has further reviewed the contents of Sheehan et al. and the corresponding 35 U.S.C. 102(b) anticipation rejection by the Examiner and the 35 U.S.C. 103 (a) rejections further in view of Mitchell et al., in the Office Action dated February 6, 2008. Applicant does not agree with the interpretation of the Examiner with respect to both the present claims and the teachings of Sheehan. and Mitchell, in particular with any supposed teachings directed to the use of two different statistical models and the association of the models with predefined pathologies and anatomical differences. Applicant presents the following claim amendments and discussion for consideration. Applicant believes that newly amended claims 1, 27,28 do not present matter that would require an additional search, in view of the already searched subject matter of original claims 8, 9, and 10, 14.

Summary of Sheehan Teachings

Applicant has reviewed the teachings of Sheehan and provides the following Sheehan summary for further consideration.

Sheehan identifies the state of the art similarly to that discussed by Applicant, namely that current modeling efforts have inherent problems in trying to use a one model fits all strategy as noted in column 5, lines 14-25:

> "Like active contour models, active shape models use *an iterative refinement algorithm* to search the image. The principal difference is that the active shape model can only be deformed in ways that *are consistent with the statistical model* derived from training data. This model of the shape of the ventricle is generated by performing a principal components analysis of the manually traced contours from a set of training images derived from ultrasound studies. The contours include a number of landmarks, which are *consistently located,*

> *represent the same point* in each study, and have gray scale characteristics that are determined from the training data.", *emphasis* added.

Sheehan goes on to discuss the need to develop a three-dimensional model using the same above-described modeling limitations commonly used for two-dimensional modeling.

Sheehan then describes that "a set of training data to derive a mesh model of an *archetype heart* that is subsequently adjusted so that its shape "explains" the shape of the patient's heart in the observed images." and "plurality of three-dimensional reconstructions of the left ventricles in *a population of hearts exhibiting a wide variety of types and severity of heart disease is used to define a three-dimensional archetype shape* of the left ventricle, and its range of shape variation (i.e., its covariance). ", see column 12 lines 8-15, *emphasis* added. Applicant submits that the teaching of the one model fits all is contrary to Applicant's invention as claimed, as discussed below. Further, Sheehan also states that the archetype model is "manually designed to fit the ventricles of *a variety of normal and diseased hearts* in the population on which the set of training data are based", *emphasis* added.

Sheehan also states, as is known in the prior art, that "Throughout this optimization process, the knowledge base of the ventricular shape embodying *the archetype shape and covariance matrix is used to constrain the adjustments* to ventricular shapes that are *anatomically allowable, as well as most probable*, given the imaging data for the patient", *emphasis* added. This passage clearly explains that performance of the one model is clearly dictated by the archetype shape and it's covariance matrix, something which is contrary to Applicant's invention as presently claimed.

Summary of Applicant's Claimed Invention

Applicant's defined problem states that modeling configurations such as those taught by Sheehan have inherent problems in trying to use a one model fits all

strategy, i.e. "the mesh model is based upon an archetype shape" – see Sheehan column 6, line 15. Applicant notes that Sheehan defines "archetype" as "A plurality of three-dimensional reconstructions of the left ventricles in a population of hearts exhibiting *a wide variety of types and severity of heart disease* is used to define a three-dimensional archetype shape of the left ventricle", *emphasis* added, see column 12 lines 12-15.

Accordingly, it is clear that Applicant's description and claims are directed to systems and methods that facilitate a solution to the modeling configurations, such as those described by Sheehan. The following two excerpts are taken from Applicant's application to illustrate the above discussion, namely:

> "An important side effect in modeling all the variations of pathological anatomy in a representative model is that the model object can "learn" the wrong shape and as a consequence find a suboptimal solution. This can be caused by the fact that that during the model object generation there is a *generalization* step based on example training images, and the model object can learn example shapes that possibly do not exist in reality.", see page 1 line 30 to page 2 line 4 of Background of Invention; and
>
> As well, "Pathological anatomy can have significantly more variability than physiological anatomy. An important side effect in modeling *all the variations* of pathological anatomy *in one model object* is that the model AAM can "learn" the wrong shape and as a consequence find a suboptimal solution. This improper learning during the learning phase can be caused by the fact that that during the model generation there is a generalization step based on the training example images 26.", see page 12 lines 25-31.

Applicant restates claim 1 of the present application for discussion purposes, with <u>emphasis</u> added:

1. (Currently Amended) An image processing system having a statistical appearance model for interpreting a digital image, the appearance model having at least one model parameter, the system comprising:

a multi-dimensional first model object including an associated first statistical relationship and configured for deforming to approximate a shape and texture of a multi-dimensional target object in the digital image, and a multi-dimensional second model object including an associated second statistical relationship and configured for deforming to approximate the shape and texture of the target object in the digital image, the second ~~model object having a shape and texture configuration~~ statistical relationship being different from the first statistical relationship ~~model object~~ such that the difference represents at least one of an anatomical geometry for a different position in a patient anatomy represented by the digital image or a different pathology;

a search module for applying the first model object to the image for generating a multi-dimensional first output object approximating the shape and texture of the target object and calculating a first error between the first output object and the target object, and for applying the second model object to the image for generating a multi-dimensional second output object approximating the shape and texture of the target object and calculating a second error between the second output object and the target object;

a selection module for comparing the first error with the second error such that one of the output objects with the least significant error is selected; and

an output module for providing data representing the selected output object to an output.

Applicant directs the Examiner's attention to page 13, lines 1-20, of Applicant's application that describes embodiments of different pathologies and different anatomical geometries that the different statistical relationships are modeled upon. Further discussion on example use of two different statistical relationships is given on page 14, lines 1-16, and page 16, lines 14-25.

Applicant also notes that original claims 8, 9, and 10, 14 state the configuration of the different model objects, which include the statistical relationships, is directed two different pathologies and/or patient anatomical differences, as now explicitly provided for in independent claims 1, 28 and 28. Accordingly, Applicant believes

that newly amended claims 1, 27,28 do not present matter that would require an additional search.

Discussion

Applicant submits that Sheehan describes how to build a *single* model and optimize that single model for automatically delineating the inner and outer surfaces of an organ that is present in a plurality of images, which are located on multiple planes in three-dimensional space. Sheehan's teachings are fundamentally different to Applicant's claimed invention that claims the application of *at least two different* statistical models for (each) segmenting a single image based on different geometrical and/or pathological considerations.

Applicant does recognize the Examiner's comments that Sheehan demonstrates the use of two model objects in column 15 line 65 to column 16 line 25, however, Applicant submits that these teachings only represent the iterative optimization process of an archetype mesh model based on a *single* covariance matrix model that incorporates a plurality of different normal and diseased hearts. In this Sheehan procedure there is only one model involved as defined, namely only one archetype shape is mentioned and only one corresponding covariance matrix is used. This use by Sheehan of a single model to cover all potential organ configurations is consistent with Applicant's stated problem and is contrary to Applicant's claimed invention.

Further, Applicant has reviewed the teachings of Mitchell and agrees with the Examiner that Mitchell also does not teach or even suggest the use of two different statistical relationships for (each) segmenting a single image, based on different geometrical and/or pathological considerations.

In view of the above emphasized claim elements and discussion, Applicant has reviewed in detail the contents of Sheehan (and Mitchell) and failed to find any explicit (or even hint of) disclosure relevant to the use of "a first statistical

relationship" and "a second statistical relationship", such that the difference in statistical relationships represents at least one of an anatomical geometry for a different position in a patient anatomy represented by the digital image or a different pathology, in trying to determine an appropriate output object that best approximates the same target object in a selected digital image. Accordingly, Applicant considers the 35 U.S.C. 102(b) rejection of claims 1-6,9,11-13,15-18, and 27,28 as overcome. Further, Applicant considers the 35 U.S.C. 103(a) rejection of claims 7-8, 10, 14 as moot in view of Applicant's discussion and claim amendments.

In view of the above, Applicant considers the currently amended claims as allowable and requests reconsideration to that effect. The Examiner is invited to contact the undersigned for any questions on the above.

Respectfully submitted,

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